

*Shelve in Stacks S.B.T.*

# Highway Safety Literature

An Announcement  
of Recent Acquisitions. . .

HSL No. 71-7  
February 19, 1971



THIS ISSUE CONTAINS:  
HS-008 545 - HS-008 584

*U.S. Department of Transportation / National Highway Traffic Safety Administration*

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7-1-7

# HIGHWAY SAFETY LITERATURE

## AN ANNOUNCEMENT OF RECENT ACQUISITIONS

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### INTRODUCTION

Publications announced in *Highway Safety Literature* include the most recent additions to the collection of the NHTSA Scientific & Technical Information Service. Subject areas covered include all phases of highway, motor vehicle, and traffic safety, especially those encompassed by the National Traffic and Motor Vehicle Safety Act of 1966 and the Highway Safety Act of 1966.

Individual issues of *HSL* are numbered according to the year and the issue number within that year; thus, 71 designates the year and 1, 2, 3, etc. the individual issues. To aid the user in location citations by the HS-number, the cover bears the inclusive entry numbers for each issue.

Entries in *HSL* are arranged according to the revised NHTSA Subject Category List shown in the Table of Contents. The List is a two-level arrangement consisting of five major subject fields subdivided into 58 subject groups. Documents related directly to the National Highway Traffic Safety

Administration (NHTSA) are announced in a separate section headed NHTSA DOCUMENTS and are numbered in five distinct series: NHTSA Accident Investigation Reports (HS-600 000 series), NHTSA Compliance Test Reports (HS-610 000 series), NHTSA Contractors Reports (HS-800 000 series), NHTSA Staff Speeches, Papers, etc. (HS-810 000 series), and NHTSA Imprints (HS-820 000 series). For NHTSA DOCUMENTS in series HS-600 000 and HS-610 000, individual full case reports are available for inspection at the National Highway Traffic Safety Administration; or for purchase from NTIS (see page ii). Although announced together in a separate section, these documents are also assigned specific subject categories for machine retrieval.

A document which contains a number of separate articles is announced as a complete volume in the subject category most applicable to it as a whole. Entries for the individual articles appear in their most specific subject category.

### SAMPLE ENTRIES

#### Subject Category Array

NHTSA Accession no..... HS-800 218 Fld. 5/21; 5/9

Title of document..... AN INVESTIGATION OF USED CAR SAFETY STANDARDS--SAFETY INDEX: FINAL REPORT. VOL. 6 - APPENDICES G-L

Personal author(s)..... by E. N. Wells; J. P. Fitzmaurice; C. E. Guilliams; S. R. Kalin; P. D. Williams

Corporate author..... Operations Research, Inc., Silver Spring, Md., 015000

Collation.....

Publication date..... 12 Sep 1969 150p  
Contract FH-11-6921  
Report no. ORI-TR-553-Vol-6; PB-190 523

Abstract..... Appendices G-L to this study of used car safety standards include: indenture model diagrams for classes I-IV motor trucks; degradation, wear, and failure data for motor truck classes I-IV; and safety index tables for classes I-IV motor trucks.

Search terms: Wear /Trucks;  
Failures /Trucks; Used cars; Inspection standards /Trucks; Inspection standards /Data

AVAILABILITY: NTIS

HS-004 497 Fld. 5/19

#### AUTO THEFT--THE PROBLEM AND THE CHALLENGE

by Thomas A. Williams, Sr.

Journal citation . . . Published in *FBI Law Enforcement Bulletin* v37 n12 p15-7 (Dec 1968)

Gives figures on the extent of the auto theft problem and comments on antitheft devices available now or in the planning stage.

Search terms: Theft, Theft protection, Stolen cars

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NOTE: ( ) Numbers in parentheses following certain subject groups indicate the Highway Safety Program Standards (No. 1, and up) and/or Federal Motor Vehicle Safety Standards (No. 101 and up) which may apply to these groups.

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\* All Federal Motor Vehicle Safety Standards apply to passenger vehicles. An asterisk before a subject group indicates additional types of vehicles to which the indicated standards may apply.

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NOTE: Material published in Highway Safety Literature (HSL) is intended for the information and assistance of the motor vehicle and highway safety community. While brands names, equipment model names and identification, and companies may be mentioned from time to time, this data is included as an information service. Inclusion of this information in the HSL should not, under any circumstances, be construed as an endorsement or an approval by the National Highway Traffic Safety Administration, Department of Transportation of any particular product, course, or equipment.

Harry A. Feinberg  
Managing Editor

## AVAILABILITY OF DOCUMENTS AND INSTRUCTIONS FOR ORDERING

Department of Transportation personnel may borrow copies of publications directly from the NHTSA. Outside the Washington, D.C. area, phone (202) 426-2768. In Washington, D.C. area, use government ID, phone 118-62768. Non-DOT personnel should contact their company or agency libraries for assistance.

Journals cited may be obtained through most research libraries.

Contractors' reports and other documents can usually be obtained as indicated under AVAILABILITY. However, there is no certainty that retention copies will be available for more than a limited period after a document is issued.

The more common distribution sources are identified by symbols which are explained below:

**NTIS:** National Technical Information Service (formerly Clearinghouse for Federal Scientific and Technical Information—CFSTI), Springfield, Va. 22151. Order by accession number: *HS, AD, or PB*. Prepayment is required by NTIS (CFSTI) coupon (GPO coupons are not acceptable), check, or money order (made payable to the NTIS). *HC* (Paper copy; full size original or reduced

facsimile) \$3.00 up; *MF* (microfiche approximately 4x6" negative sheet film; reader required) \$0.95.

**GPO:** Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. Give corporate author, title, personal author, and report number. Prepayment is required by GPO coupon (NTIS [CFSTI] coupons are not acceptable), check or money order (made payable to the Superintendent of Documents).

**HRB:** Highway Research Board, National Academy of Sciences, 2101 Constitution Ave., N. W., Washington, D. C. 20418.

**NHTSA:** National Highway Traffic Safety Administration General Services Division, Washington, D.C. 20591 (Telephone (202) 426-0874).

**SAE:** Society of Automotive Engineers, Dept. HSL, 2 Pennsylvania Plaza, New York, N.Y. 10001. Order by SAE report number. Prices given are list; discounts are available to members and sometimes to libraries and U.S. Government Agencies. Prepayment is required; orders without payment are subject to a \$1 handling charge.

### IMPORTANT

WHEN REQUESTING a document, to be absolutely sure you receive what you order, give the accession number (HS, PB, AD number) or report number (in cases such as an SAE document), title of report, and the personal or corporate author (whichever is cited). When requesting an HS-numbered document from NTIS (CFSTI), add DOT/ to the prefix HS-; example HS-800 000 should be ordered as DOT/HS-800 000.

### SPECIAL NOTICE

#### NEW PRICES FOR DOCUMENTS AVAILABLE FROM NTIS

On January 1, 1971, the National Technical Information Service (NTIS) increased the prices for documents in certain categories. These increases were made necessary by increased costs. Prices are now as follows:

#### PAPER COPY

Most documents announced after January 1, 1969, are priced:

1 to 300 pages	\$3.00
301 to 600 pages	6.00
601 to 900 pages	9.00
Over 900 pages	Exception Price

Two years after announcement, documents having 300 pages or less will have a service charge of \$3.00 added to the announced price. No service charge will be added for documents over 300 pages.

Documents announced prior to January 1, 1969, have a service charge of \$3.00 added to the announced price.

#### MICROFICHE

Microfiche reproduction of documents on a demand basis are priced at 95 cents per document.

Documents available on Standing Order through NTIS Selective Dissemination of Microfiche Service (SDM) are priced at 35 cents per document.

## 1/0 ACCIDENTS

## 1/1 Emergency Services

HS-008 545 Fld. 1/1

## EMERGENCY MEDICAL PROBLEMS IN RURAL AREAS

by Valentin Wohlaue

Published in *Rocky Mountain Medical Journal* v64 p43-8 (Aug 1967)

Presented at the American Medical Association meeting, St. Louis, Feb 18-19, 1967.

The problems of emergency medical services in rural areas are discussed, and it is suggested that rural populations have shown more initiative to help themselves than city dwellers. Aspects discussed include medical self help training, packaged disaster hospitals, training for medical personnel, ambulance service, blood banks, poison control, and accident prevention.

Search terms: Emergency medical services/Rural areas; Hospitals; Ambulance personnel; Ambulances; Accident prevention; First aid; Disasters/Emergency medical services; Poison control centers; Blood banks; Medical education/Rural areas

## 1/2 Injuries

HS-008 546 Fld. 1/2

## DIED IN HOSPITAL. A THREE YEAR STUDY OF DEATHS FOLLOWING TRAUMA

by Frank H. Van Wagoner

Published in *Journal of Trauma* v1 p401-8 (1961)

6 refs

The records of 606 adult males who died within two weeks of hospital admission have been examined. Of these, 376 were injured in vehicle accidents. At least 96 could have survived with prompt diagnosis and adequate treatment. Another 103 had such limited treatment that an appreciable number could probably have been salvaged. Over half the acceptably treated cases were uncomplicated head

injuries, pointing out the necessity for improving treatment of head trauma. Physicians must be better trained in the surgery of trauma if such needless loss of life is to be avoided.

Search terms: Male drivers/Fatalities; Head injuries/Fatalities; Medical treatment/Accident survivability; Diagnosis/Accident survivability

## 1/3 Investigation and Records

HS-008 547 Fld. 1/3

## ROAD ACCIDENTS

by J. J. Leeming

Published in *Medicine, Science and the Law* v3 p511-6 (Oct 1962)

Aspects of the accident problem are discussed, including human error, the attempt to prevent accidents through legal penalties, the role of the vehicle and the road in accidents, and the attempt to find solutions through engineering. A comparison of accident rates before and after highway improvements at certain locations is made.

Search terms: Accident causes; Accident prevention/Penalties; Driver vehicle interface; Man machine systems; Driver road interface; Accident rates/Highway improvements; Highway improvements/Accident location

HS-008 548 Fld. 1/3; 3/1

## A NOTE ON AUTOMOBILE-TRAM (STREETCAR) FATAL ACCIDENTS AND ALCOHOL IN THE CITY OF MELBOURNE

by J. H. W. Birrell

Published in *Medical Journal of Australia* v2 n1 p1-4 (1 Jul 1967)

8 refs

Twenty-five fatal car-streetcar collisions during the years 1961-66 have been reviewed. Alcoholism and youth played major roles. All 25 car drivers were male and all were considered clearly responsible for their accidents. All collisions occurred between 6 p.m. and 6 a.m. In 19 cases the streetcar

was struck head on, usually at high speed, by the auto. Blood alcohol levels of the drivers are discussed. The drivers were mostly 24 years of age or less, were largely unskilled, and included a significant number of known alcoholics and drivers with criminal records.

Search terms: Streetcars/Collisions; Male drivers/Fatalities; Male drivers/Blood alcohol levels; Male drivers/Alcoholism; Male drivers/Sociological factors; Accident responsibility/Male drivers; Time of day/Accident factors; Age factor in accidents/Male drivers; Head on collisions/Streetcars; Accident studies/Melbourne; High speed/Head on collisions

HS-008 549 Fld. 1/3; 3/4

## HUMAN VARIABLES IN TRAFFIC ACCIDENTS: A DIGEST OF RESEARCH

by Leon G. Goldstein

Published in *Traffic Safety Research Review* v8 n1 p26-31 (Mar 1964)

54 refs

The literature concerning psychological characteristics and accidents is reviewed, and it is argued that, so far as human variables are concerned, accidents are largely a function of age, alcohol, and attitudes. The literature discussed is grouped under the headings of driver behavior variables; visual measures; reaction time measures; several types of perception variables; personal, emotional, and attitudinal measures; background and sociological measures; fatigue; age; and alcohol.

Search terms: Human factors/Accident causes; Driver behavior/Accident factors; Vision/Accident factors; Reaction time/Accident factors; Perception/Accident factors; Driver attitudes/Accident factors; Sociological factors/Accident factors; Driver fatigue/Accident factors; Age factor in accidents; Alcoholic beverages/Accident factors; Drinking drivers; Driver intoxication/Accident factors; Psychological factors/Reviews; Accident causes/Reviews; Emotions/Accident factors

HS-008 550 Fld. 1/3; 4/5

**SURVEILLANCE OF ACCIDENT LOCATIONS BY ELECTRONIC-PROCESSING METHODS**

by Richard N. Smith

Published in *Highway Research Record* n188 p90-126 (1967)

Presented at the Highway Research Board 46th annual meeting.

The objective of this study was to determine the feasibility of computer editing of accident data by producing tabulations which could be used as aids in identifying, rating, and analyzing problem locations. The surveillance system was designed to accomplish by electronic data processing methods much that is now done manually. The surveillance tables include monthly accident summary of all accidents listed in route order; quarterly accident concentration listing; and details of each accident. Costs of the program in California are presented.

Search terms: Data processing /Costs; Accident data /Data processing; Accident location /Data processing; Accident surveillance /California; Accident location /California; Accident reports /Data processing; Accident surveillance /Costs

## 2/0 HIGHWAY SAFETY

### 2/2 Communications

HS-008 551 Fld. 2/2

**HIGHWAY COMMUNICATIONS. A REVIEW OF PROPOSED SYSTEMS**

by William S. Halstead; Guy Kelcey

Published in *Municipal Signal Engineer* v31 n5 p21-8 (Sep-Oct 1966)

Based on a paper presented at the Institute of Traffic Engineers 35th annual meeting.

Several systems for highway communication are described. Two basically different methods are used, one utilizing induction techniques and cables installed within the highway

right of way, and the second employing high frequency radio and space radiation with antennas. The authors consider the induction radio method more advantageous. Several guidance and automatic control systems are described.

Search terms: Highway communication; Radio communication /Highway communication; Cables /Highway communication; Guidance systems /Highway communication; Automatic control /Highway communication; Driver aid, information, and routing system

HS-008 552 Fld. 2/2

**DETECTION AND LOCATION OF OFF-THE-SHOULDER VEHICLES**

by R. L. Cosgriff; R. B. Lackey

Published in *Highway Research Board Bulletin* n338 p1-3 (1962)

A system for detecting stranded vehicles on the Interstate Highway System is described. The technique involves resistance measurements and utilizes cables buried on both sides of the highway, devices to indicate the location of the vehicle, and an alarm in a central station. This system has a relatively low initial cost, is hard to vandalize, and gives the motorist a signal that help is on the way. Several other systems for detecting stranded vehicles are compared.

Search terms: Disabled vehicles /Interstate Highway System; Highway communication /Disabled vehicles; Detectors /Disabled vehicles; Electronic devices /Detectors; Vandalism /Detectors; Costs /Detectors

### 2/4 Design and Construction

HS-008 553 Fld. 2/4; 3/12

**GLARE SCREEN FOR DIVIDED HIGHWAYS**

by Rudolph Hofer, Jr.

Published in *Highway Research Board Bulletin* n336 p95-101 (1962)

To make use of the full sight distances provided by modern highways, motorists must use their high beam headlights, causing glare to oncoming

motorists. The forms of glare screen in use include plantings of shrubbery, wood or metal fences placed parallel to the center line of the highway, and intermittent fences of wood or metal placed in a louvered pattern or placed at 90 degree angle to the center line of the highway. The screen found most satisfactory is a line of expanded metal mesh, erected in the median strip, parallel to the center line of the highway.

Search terms: High beamed headlamps /Glare; Glare screens; Headlamp glare /Glare reduction; Fences /Glare reduction

### 2/5 Lighting

HS-008 554 Fld. 2/5

**STREET LIGHTING IN CENTRAL AND EASTERN EUROPE**

by Jiri Svehla

Published in *Public Lighting* v31 n135 p229-45 (Dec 1966)

The street lighting systems, standards, and equipment of Czechoslovakia, Hungary, East Germany, Poland, Yugoslavia, Bulgaria, and the Soviet Union are described.

Search terms: Street lighting /Czechoslovakia; Street lighting /East Germany; Street lighting /Poland; Street lighting /Yugoslavia; Street lighting /Bulgaria; Street lighting /USSR; Street lighting /Hungary

HS-008 555 Fld. 2/5; 2/9

**THE LIGHTING OF TRAFFIC SIGNS AND ASSOCIATED TRAFFIC CONTROL DEVICES**

by J. A. Reid

Published in *Public Lighting* v29 n127 p252-65 (Dec 1964)

26 refs

A survey of the problem of lighting of traffic signs and of the function and design of other lighting devices used for traffic control has been made. The use of reflective devices for traffic guidance at night has also been briefly described. The survey was made in Great Britain.

Search terms: Sign lighting /Great Britain; Traffic control devices /Lighting; Reflectors; Lighting equipment /Surveys; Traffic signs /Lighting

HS-008 556 Fld. 2/5; 3/12

# AN INSTRUMENT FOR ASSESSMENT OF VISIBILITY UNDER HIGHWAY LIGHTING CONDITIONS

by A. E. Simmons

Published in *Highway Research Board Bulletin* n336 p76-94 (1962)

6 refs

An analysis of the problem of visibility assessment under highway lighting conditions is made, and factors that could provide an index to visual performance under these conditions are evaluated. Findings have resulted in a mathematical analysis of visual assessment and visibility criteria for highway lighting. An instrument is described which provides an objective determination of relative visibility. The device consists of a dual monocular system with suitable optical wedges arranged to reduce a two degree central portion of the roadway area under observation to a contrast threshold, while maintaining a constant eye adaptation, thus providing a relative index of visibility. The visibility index is calibrated in terms of the contrast between an object of fixed size and its background.

Search terms: Highway lighting /Measuring instruments; Visibility /Measuring instruments; Visibility /Mathematical analysis; Highway lighting /Contrast; Contrast /Visibility

HS-008 557 Fld. 2/5; 3/12

# VISUAL DATA ON ROADWAY LIGHTING

by Charles H. Rex

Published in *Highway Research Board Bulletin* n336 p61-75 (1962)

26 refs

Seeing factor effectiveness ratings for road lighting are presented. Such ratings provide an essential basis for highway engineering evaluation of traffic, economic, and human benefits.

About twice as much pavement brightness is required for equivalent visibility when the target is dynamic instead of static. Measurements made with the new Blackwell portable visual task evaluator are reported and compared with those obtained with the Finch visibility meter.

Search terms: Highway lighting /Measuring instruments; Visibility /Measuring instruments; Brightness /Pavements; Pavements /Visibility

## 2/9 Traffic Control

HS-008 558 Fld. 2/9

# COMMENTS ON AN ELECTRONIC HIGHWAY—SOME SPECIFIC TECHNIQUES AND SUGGESTIONS FOR A TEST ROADWAY

by George H. Brown

Published in *Highway Research Board Bulletin* n338 p4-7 (1962)

The disciplines of electronic and highway engineering can be brought closer together so that maximum use may be realized in application of electronic research to highways. Some of the factors involved in cooperative endeavor are described. Specific techniques used by RCA in its systems approach to an electronic highway are discussed, and a cooperative project on public highways is suggested.

Search terms: Automatic highways; Automatic control; Electronic devices /Highway engineering

HS-008 559 Fld. 2/9

# PROPOSED SPECIFICATIONS FOR LOCATION OF SIGNAL FACES

by Paul C. Box

Published in *Traffic Control* v32 n1 p19-22 (Jan-Feb 1967)

The specifications for signal faces in the Manual on Uniform Traffic Control Devices are discussed. A revision is suggested which would combine flexibility of installation techniques with uniformity and visibility.

Search terms: Traffic signal faces /Specifications; Traffic signal faces /

Uniformity; Traffic signal faces /Visibility; Manual on Uniform Traffic Control Devices for Streets and Highways

HS-008 560 Fld. 2/9

# TRAFFIC PACER

by Harold M. Morrison; Arthur F. Underwood; Robert L. Bierley

Published in *Highway Research Board Bulletin* n338 p40-68 (1962)

The design and evaluation of a traffic pacer system installed on a highway near the General Motors Technical Center are described. The traffic pacer causes changing speed signs and stop signs between intersections to group traffic so that it may pass through the intersection with a moving start. The control system is intended to increase intersection capacity and reduce delays and trip time. The criteria used to compare this system with two others now in use were: average trip time, average number of stops, and average velocity; intersection capacity; queue length; safety; and public opinion.

Search terms: Traffic control devices /Intersections; Traffic capacity /Intersections; Travel time /Traffic control devices; Traffic signal delay time /Intersections; Public opinion /Traffic control devices; Speed patterns /Traffic control devices; Pacer signals /Traffic control; Stop signs /Traffic control; Speed signs /Traffic control; Queueing theory /Traffic control; Highway safety /Pacer signals

HS-008 561 Fld. 2/9

# SAFETY AND SUCCESS IN PAVEMENT MARKING

by Lloyd H. Johnson; George E. Hively; William G. Galloway; Robert W. Roseveare; Thomas H. Ratchford; A. L. McMillion; Lawrence Ploumen; Leon Morrissey; Bruce W. McClain; Elton B. Evans; Frank Heide; W. L. Warren

Published in *Better Roads* p16-17, 20, 23 (Aug 1967)

Problems encountered in maintaining pavement markings are discussed. The problems include smearing of freshly

**2/9 Traffic Control (Cont'd)**

HS-008 561 (Cont'd)

painted stripes, knocking down of cones, protection of crews doing the painting, traffic management around work areas.

Search terms: Pavement markings; Cones; Traffic control/Highway maintenance; Paints/Pavement markings

HS-008 562 Fld. 2/9

**METHODS OF TRAFFIC MEASUREMENT - DETERMINATION OF NUMBER AND WEIGHT OF VEHICLES**

by Stig Edholm

Published in *Highway Research Board Bulletin* n338 p81-99 (1962)

The National Swedish Road Research Institute has designed and constructed a small transportable scale for measuring the axle loads of vehicles in motion. The specifications of the scale are described. The results of measurements at about 200 weighing sites distributed over Sweden indicate that certain simple relations exist between the number of vehicles passing a road section per unit time and the total vehicle weight or the total payload of these vehicles in each group of vehicles. Extensive investigations have been made to determine these relations. A small-sized traffic counter is being tested at the present time. It counts the number of vehicles passing the road section under observation and records the group of vehicles to which each individual vehicle belongs.

Search terms: Traffic surveys/Sweden; Vehicle weight/Measuring instruments; Axle load measurements; Traffic counters; Traffic characteristics/Sweden

HS-008 563 Fld. 2/9

**REQUISITE LUMINANCE CHARACTERISTICS FOR REFLECTIVE SIGNS**

by J. O. Elstad; J. T. Fitzpatrick; H. L. Woltman

Published in *Highway Research Board Bulletin* n336 p51-60 (1962)

6 refs

This study is designed to establish reflective characteristics required for any installation and suggests a brightness range for typical sign environments. Ideally, consistent luminance would be maintained through approach distances for all sign positions. Iso-illuminance and iso-divergence data indicate varying illuminance and retro-reflective efficiency throughout the approach. However, inverse relationship at generally useful distances indicates little modification of the classic divergence curve is necessary for materials considered. Foot candles needed for signs in various situations are discussed.

Search terms: Reflectorized signs/Luminance; Sign legibility

HS-008 564 Fld. 2/9

**INTERSECTION TRAFFIC CONTROL THROUGH COORDINATION OF APPROACH SPEED**

by S. M. Breuning

Published in *Highway Research Board Bulletin* n338 p69-80 (1962)

The principles and theories of controlling approach speed to intersections and the fundamentals of the traffic pacer are discussed. The low cost of signs for controlling speed of approach should encourage experimentation with this method. Traffic can be funneled into the intersection through speed control. Other concepts of intersection control are compared. Mathematical models of the traffic funnel concept are included.

Search terms: Pacer signals/Speed control; Pacer signals/Intersections; Traffic control devices/Intersections; Signalized intersections/Speed control

HS-008 565 Fld. 2/9; 3/12

**TRAFFIC OPERATIONS AND DRIVER PERFORMANCE AS RELATED TO VARIOUS CONDITIONS OF NIGHTTIME VISIBILITY**

by Matthew J. Huber

Published in *Highway Research Board Bulletin* n336 p37-50 (1962)

An experimental reflectorized color guidance system for highway signs was installed at a cloverleaf interchange. Experimental results of traffic surveys and driver interviews are described. Signs, pavement markings, and delineators were used. Yellow and blue materials were compared. An existing pavement lighting installation permitted the study of various combinations of day and night visibility conditions. Conclusions are presented describing the reactions of drivers to the experiments, especially at entrance and exit ramps.

Search terms: Highway signs/Sign color; Pavement markings/Blue; Pavement markings/Yellow; Sign color/Yellow; Sign color/Blue; Delineators (traffic)/Blue; Delineators (traffic)/Yellow; Cloverleaf ramps/Highway signs; Driver interviews/Sign color; Driver interviews/Pavement marking; Driver interviews/Delineators (traffic); Highway lighting/Cloverleaf ramps; Night visibility/Reflecting surfaces; Night visibility/Highway lighting; Reflectorized pavement markings; Reflectorized signs; Reflectorized road shoulder markings

HS-008 566 Fld. 2/9; 4/5

**PILOT STUDY OF THE AUTOMATIC CONTROL OF TRAFFIC SIGNALS BY A GENERAL PURPOSE ELECTRONIC COMPUTER**

by Leonard Casciato; Sam Cass

Published in *Highway Research Board Bulletin* n338 p28-39 (1962)

An experiment was conducted in Toronto to demonstrate that an electronic computer could be connected into an existing traffic signal network to provide a very flexible, reliable, and powerful coordinated signal system free of most of the limitations of existing traffic signal control equipment and to obtain an impression of how this system could be used to improve traffic flow. The system and its operation are described, and the benefits of a full-scale system are outlined.



Search terms: Electronic traffic control /Toronto; Traffic flow /Electronic traffic control; Traffic signal networks /Electronic traffic control; Traffic signals /Electronic traffic control

HS-008 567 Fld. 2/9; 4/7

#### INTERSECTION DELAY OBTAINED BY SIMULATING TRAFFIC ON A COMPUTER

by James H. Kell

Published in *Highway Research Record* n15 p73-97 (1963)

8 refs

The model used in this study consisted of the time simulation of an orthogonal intersection of two two-lane, two-way streets with the minor street being controlled by stop signs. Approximately 14,000 hours of traffic were simulated on an IBM 701. During most of the simulation, turning movements were held constant to 10% left and 10% right. Additional runs were made at selected volumes where turning movements were varied to determine the effect of the turns on intersection delay. Total intersection delay was the final output of the simulation. This is related to input volumes by multiple regression techniques. These results are compared to the output from the second phase of the study, a signalized intersection, to provide factual data concerning the effect of installing a traffic signal at an intersection.

Search terms: Traffic simulation / Computerized simulation; Traffic simulation /Turning; Traffic simulation /Intersections; Traffic simulation /Right turns; Traffic simulation /Left turns; Traffic signal delay time /Intersections; Regression analysis /Traffic volume; Signalized intersections /Traffic simulation; Mathematical models /Intersections

HS-008 568 Fld. 2/9; 4/8

#### CONFRONTATION OF TRAFFIC PROBLEMS IN THE ATHENS AREA

by Odysseus N. Papadakis

Published in *Traffic Engineering* v37 n10 p31-6 (Jul 1967)

Traffic congestion problems of Athens are described, and attempts to solve them through traffic engineering are discussed. A survey of the area was made, including data collection and analysis, study of traffic zones, land use, testing of alternatives of highway networks and public transit systems, study of parking habits. Conclusions of the survey are discussed and recommendations for future transportation planning are made.

Search terms: Traffic congestion / Athens; Traffic engineering /Athens; Traffic surveys /Athens; Land use / Transportation planning; Transportation planning /Athens; Highway planning /Athens; Public transportation /Athens; Parking / Athens; Transportation planning / Data acquisition; Transportation planning /Data processing

HS-008 569 Fld. 2/9; 5/18

#### A NEW VEHICLE GUIDANCE AND SPEED CONTROL SYSTEM

by Robert A. Spangler; Fred M. Snell

Published in *Highway Research Board Bulletin* n338 p20-7 (1962)

A new vehicle guidance and speed control system, using only passive roadbed equipment, is presented. The operation of the system is based on the detection of position and speed information by means of radio-frequency magnetic fields induced in roadbed loops by a vehicle-borne generator. Advantages of the system include: passive, durable, and inexpensive road equipment; individual vehicle-borne active equipment, presenting no standing wave problem and involving low power levels; detection equipment entirely phase dependent rather than amplitude dependent; inherent damping of lateral acceleration; speed control easily subject to external moderation; adequate safety features and adaptability for future extended control functions, including completely programmed travel.

Search terms: Vehicle guidance / Automatic control; Guidance systems; Speed control; Detectors; Acceleration damping

### 3/0 HUMAN FACTORS

#### 3/5 Driver Education

HS-008 570 Fld. 3/5

#### DEFENSIVENESS IS EMPHASIZED IN SAN JOSE'S DRIVER TRAINING

by R. L. Nailen

Published in *Fire Engineering* v120 n11 p50-1 (Nov 1967)

A defensive driver training course for the San Jose, California, fire department's drivers is described. The course is intended to make the firemen safer drivers both on and off duty. Course content is outlined.

Search terms: Defensive driving / Professional drivers; Firemen / Defensive driving; Driver improvement schools

HS-008 571 Fld. 3/5

#### AN EXPERIMENTAL FIELD TEST OF THE SMITH-CUMMINGS-SHERMAN DRIVER TRAINING SYSTEM

by Donald E. Payne; Joseph E. Barmack

Published in *Traffic Safety Research Review* v7 n1 p10-4 (Mar 1963)

7 refs

A training program for professional drivers is described. The principles of the system are: developing systematic search habits to detect potential driving hazards; and using driving strategies to dispose of potential hazards before they become critical. From a field test of the system it was concluded that its effectiveness in preventing certain types of accidents by experienced professional drivers was not demonstrated unequivocally; that the system might be more effective with beginners; that the effectiveness of the system cannot be evaluated independently of the trainers; and that the system cannot be recommended for fleet use apart from considering the effectiveness of the trainers.

Search terms: Fleet driver training /Driver education evaluation; Accident prevention /Fleet driver training; Driver education

**3/5 Driver Education (Cont'd)**

HS-008 571 (Cont'd)

evaluation /Instructors; Professional drivers /Driver education evaluation; Defensive driving /Fleet driver training; Field tests /Driver education evaluation

**3/6 Driver Licensing**

HS-008 572 Fld. 3/6

**THE COST AND CURE OF HIGHWAY ACCIDENTS**

by Roy G. Poulsen

Published in *Rhode Island Alumni Bulletin* v46 n6 p1-3 (Dec 1966)

It is suggested that bad driving is the most common cause of accidents. Suggestions are made for dealing with this problem, including retesting of drivers with poor records; probationary driver license status for violators; more realistic road tests for driver license applicants; color-coded license plates to display a driver's accident record to all; improvement in vehicle inspections. Economic costs of accidents are also discussed.

Search terms: Problem drivers / Driver license renewal; Driver license examination /Road tests; Driver records /Driver license restrictions; Motor vehicle inspection; Accident costs; License plates /Color; Traffic violations /Driver license restrictions

HS-008 573 Fld. 3/6

**139 MILLION DRIVERS IN 1980**

by E. M. Cope and Arlene R. Mundy

Published in *Public Roads* v33 n4 p68-79 (Oct 1964)

Estimates of the numbers, sex, and age groups of licensed drivers are given for states and the nation as a whole. It is forecast that the number of drivers' licenses will reach 125 million by 1975 and 139 million by 1980. State statistics presently kept vary in completeness.

Search terms: Driver licensing / Statistics; Driver licensing / Forecasting; Age factors /Driver licensing; Sex factors /Driver licensing; Male drivers /Statistics; Female drivers /Statistics

**3/7 Drugs Other Than Alcohol**

HS-008 574 Fld. 3/7

**THE DRIVER AND PEDESTRIAN**

by L. G. Norman

Published in *Medicine, Science and The Law* v3 p411-6 (Oct 1962)

The role of drugs as a cause of accidents is discussed. Physicians should advise their patients when they are being given drugs which will slow their reactions or otherwise make them unsafe drivers. The reaction times, accident proneness, and psychological characteristics of professional drivers are discussed.

Search terms: Accident causes / Drugs; Reaction time /Drivers; Reaction time /Drugs; Physicians / Highway safety; Professional drivers /Reaction time; Professional drivers /Accident proneness; Professional drivers /Psychological factors

**3/12 Vision**

HS-008 575 Fld. 3/12

**FLICKER FUSION, DARK ADAPTATION AND AGE AS PREDICTORS OF NIGHT VISION**

by Richard G. Domey

Published in *Highway Research Board Bulletin* n336 p22-5 (1962)

Dark adaptation and critical flicker fusion thresholds for 60 subjects ranging in age from 16 through 89 were obtained. A methodical analysis of the statistical interrelationship among dark adaptation thresholds and critical flicker fusion thresholds as function of surround, light/dark ratio, and age were systematically examined. The prediction of dark adaptation threshold at the 40th minute was significantly increased by certain critical flicker fusion data.

Search terms: Dark adaptation / Night vision; Flicker frequency / Night vision; Vision age changes / Night vision; Night vision /Statistical analysis

HS-008 576 Fld. 3/12

**EFFECTS OF AGE ON PERIPHERAL VISION**

by Ernst Wolf

Published in *Highway Research Board Bulletin* n336 p26-32 (1962)

15 refs

Changes in visual sensitivity with age at photopic, mesopic, and scotopic luminance levels have been found in studies on visual acuity, dark adaptation, and flicker. It also has been shown that sensitivity to glare increases with age. Approximately at the age of 40 the pace of change is accelerated. Information on visual performance in the peripheral visual field is obtained by studies on dynamic visual acuity and flicker perimetry. Perimetric fields obtained by the flicker method in individuals between the ages of 6 and 93 years under various experimental conditions are presented, and the effects of alertness, training, and experience are discussed.

Search terms: Glare tolerances / Vision age changes; Dark adaptation; Peripheral vision /Vision age changes; Visual fields; Visual acuity; Flicker frequency

HS-008 577 Fld. 3/12

**ACCOMMODATION, CONVERGENCE, AND THEIR RELATION TO APPARENT DISTANCE**

by Adelbert Ames, Jr.; William H. Ittelson

Published in *Optometric Weekly* v54 n44 p2041-6 (31 Oct 1963)

Reprinted from *The Journal of Psychology* v30 p43-62 (1950).

This paper, considered a classic in its field, deals with the relationship of image producing mechanisms to apparent distance and to actual distance when these two distances differ. Experiments consisted of presenting the observer with a size cue of a distance which is different from the actual distance, and then measuring the apparent distance, accommodation,

and convergence. Various conditions of monocular and binocular observation are studied using both stationary and apparently moving stimuli. Applications of the experiments to perception theory are discussed.

Search terms: Distance perception; Visual perception; Perception

HS-008 578 Fld. 3/12

#### ARE MEANINGFUL NIGHT VISION TESTS FOR DRIVERS FEASIBLE?

by Ingeborg Schmidt

Published in *American Journal of Optometry and Archives of American Academy of Optometry* v38 n6 p295-348 (Jun 1961)

refs

The feasibility of compulsory night vision tests for driver license candidates has been studied, and a literature review is presented. The visual environment and the visual tasks involved in night driving are described, an analysis of the experimental data shown to determine whether one visual function can substitute for another in a test, a survey given of the factors affecting the efficiency of the eye functions involved, and general requirements for a night vision testing procedure discussed and instruments described.

Search terms: Vision tests / Reviews; Night vision / Vision tests; Night vision / Reviews; Driver license standards / Night vision; Driving tasks / Vision

HS-008 579 Fld. 3/12

#### SEEING FOR NIGHT DRIVING

by Oscar W. Richards

Published in *Journal of the American Optometric Association* v32 n3 p211-4 (Oct 1960)

Problems of night vision are discussed, including visual field and acuity, color coding and aberrations, reduced depth, time needed for seeing, glare. Proper eye care can alleviate some of these difficulties.

Search terms: Night vision / Night driving; Visual fields / Night driving; Visual acuity / Night driving; Color perception / Night driving; Glare / Night driving; Reaction time / Visual perception

HS-008 580 Fld. 3/12

#### DISCOVERIES OF THE ILLUSION LAB: EYES CAN DECEIVE

by Lincoln Barnett

Published in *Journal of the American Optometric Association* v33 n8 p606-11 (Mar 1962)

The Perception Demonstration Center at Princeton University is described. A number of experiments dealing with the psychology of vision are discussed.

Search terms: Visual perception; Vision / Psychological factors

### 4/0 OTHER SAFETY-RELATED AREAS

#### 4/1 Codes and Laws

HS-008 581 Fld. 4/1; 1/3

#### WISCONSIN LAW GOVERNING AUTOMOBILE ACCIDENTS. PT. 1

by Richard V. Campbell

Published in *Wisconsin Law Review* v1962 p240-79 (Mar 1962)

206 refs

Major developments of the past few years on automobile law are presented, emphasizing the more controversial aspects. Topics discussed: relative rights and obligations of operator, passenger, and pedestrian; negligence; proximate cause of accidents and injuries.

Search terms: Liability; Negligence; Accident causes / Legal factors; Injury causes / Legal factors; Drivers / Legal factors; Passengers / Legal factors; Pedestrians / Legal factors; Court decisions / Automobile accidents; Court decisions / Wisconsin

#### 4/7 Mathematical Sciences

HS-008 582 Fld. 4/7; 2/9

#### A SIMPLE RENEWAL MODEL OF THROUGHPUT AT AN OVERSATURATED SIGNALIZED INTERSECTION

by C. J. Ancker, Jr.; A. V. Gafarian

Published in *Transportation Research* v1 n1 p57-65 (May 1967)

5 refs

A first attempt is made to study the random fluctuations of the service curve during each go-phase at a signalized intersection. The appropriate mean value model very accurately portrays the average throughput characteristics, but variability in headways does cause significant variations in throughput characteristics. The effect of headway variability on the flow through the intersection has been studied, and the assumptions of the model are described.

Search terms: Signalized intersections / Traffic flow; Traffic flow / Mathematical models; Headway / Mathematical models

#### 4/8 Transportation Systems

HS-008 583 Fld. 4/8

#### HIGHWAY INTERCHANGE AREA DEVELOPMENT

by Floyd I. Thiel

Published in *Public Roads* v33 n8 p153-64 (Jun 1965)

27 refs

Presented at Highway Research Board 44th annual meeting, Washington, D. C., Jan 1965.

A synthesis of reports on studies defining the problem of land use development of areas near interchanges, the approaches to controlled access highways, is presented. Such development often causes traffic congestion on the interchanges. While the location of an interchange can be the stimulus for nearby economic development, problems can result if this development is not planned and controlled in relation to the traffic carrying capacity of the interchange.

Search terms: Interchanges / Land use; Interchanges / Economic factors; Highway planning / Land use; Controlled access highways / Land use; Traffic congestion / Interchanges; Traffic capacity / Interchanges

5/0 VEHICLE SAFETY

5/14 Occupant Protection

HS-008 584 Fld. 5/14

POTENTIAL EFFECTIVENESS OF  
AN AIR BAG RESTRAINT SYSTEM  
IN FRONTAL COLLISIONS

by L. G. DeYonker

General Motors Research Labs.,  
Warren, Mich. Vehicle Research Dept.,  
G10900

7 Jul 1970 30p  
Report no. VR-144

The primary objective of this study was to determine a gross estimate on the potential effectiveness of an air bag restraint system (ABRS) in terms of a reduction in fatal cases and fatalities in frontal impacts; in particular, reduction estimates were made relative to both frontal impacts and to all configurations on the basis of car damage evaluation; also of concern was the nominal barrier speed for which an ABRS would be effective as well as incremental benefits that could be expected for increased barrier speed

ABRS protection. A secondary objective was to identify hazardous objects against which an air bag restraint system should be effective for front seat occupants. Three accident configurations were examined for similarities among the most frequent/severe injury producing objects.

Search terms: Impact velocity /  
Barrier collisions; Air bag restraint  
systems / Fatality prevention; Head  
on collisions / Air bag restraint sys-  
tems; Collisions / Fatalities;  
Collisions / Damage severity index;  
Front seat passengers / Hazards;  
Drivers / Hazards



# executive summary

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## A SYNOPSIS OF A RECENTLY RELEASED NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION RESEARCH REPORT

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### AUTOMOTIVE CRASH INJURY RESEARCH (ACIR)

The Automotive Crash Injury Research (ACIR) Program was established in 1957 by Cornell Aeronautical Laboratory. In 1968, the Department of Transportation, National Highway Safety Bureau\*, assumed the co-sponsorship of this program from the U. S. Public Health Service. The National Highway Safety Bureau\* entered into a joint sponsorship of ACIR with the Automobile Manufacturers Association, a longstanding co-sponsor of this program.

\* (National Highway Safety Bureau became the National Highway Traffic Safety Administration on December 31, 1970).

Over 74,000 collision cases analyzed during the history of ACIR have produced over 100 special reports and papers regarding injury associated with the traffic systems in the United States.

When the National Highway Safety Bureau became the co-sponsor with AMA November 1, 1968, a contract, NHSB No. FH-11-7098, was awarded to CAL. The collar value awarded was \$400,000, was divided evenly by NHSB and AMA.

The funds appropriated for this continuing research during fiscal year 1970 are: NHTSA - \$324,000, and AMA - \$200,000. The research effort is now entitled: Tri-Level Accident Study.

The major goals of the FY 69 ACIR contract were improvement of the ability to collect high-quality accident data on a mass basis, evaluation of motor vehicle safety systems and measurement of the effectiveness of specific safety improvements in order to minimize injury to occupants in crash-involved passenger cars, multipurpose passenger vehicles, trucks and buses. These goals were accompanied by a collision data gathering project and collision data analysis in response to a draft statement of work prepared jointly by the Automobile Manufacturers Association, Inc., and the National Highway Safety Bureau.

Special emphasis was placed on analyses in the following areas:

- a. Accident related factors encompassing the environment, the occupant, and the vehicle;
- b. basic impact injury kinematics;
- c. early detection of design and functional problems regarding both the vehicle and the highway;
- d. early evaluation of safety features incorporated in current motor vehicles; and
- e. deformation characteristics of motor vehicles as they are affected by collision.

Particular emphases were placed on reports of collisions involving passenger cars, pickup trucks and multipurpose passenger vehicles manufactured during the years 1967, 1968, and 1969. Cases involving larger trucks and buses produced after 1959 were also reported. Reports also were completed on the other vehicles (regardless of year manufactured) involved in the same collision.

Note: During the FY 69, eight reports were issued by CAL under FH-11-7098, four of those were summarized and released on May 3, 1970. They are:

Sub-title: FLEXION-TORSION NECK INJURY IN REAR IMPACTS

Final Report

DOT/HS-800 229 or PB-191 169  
Report Date: April 1969

CAL Report No. VJ-2721-R2  
Received: 10/21/69

Sub-title: EFFICACY OF SEAT BELTS IN INJURY AND NONINJURY CRASHES IN RURAL UTAH

Final Report

DOT/HS-800 230 or PB-191 170  
Report Date: May 1969

CAL Report No. VJ-2721-R3  
Received: 10/21/69

Sub-title: COMPARISON OF DOOR OPENING FREQUENCY IN 1967-1968 CARS WITH EARLIER MODEL U.S. CARS

Final Report

DOT/HS-800 231 or PB-191 171  
Report Date: May 1969

CAL Report No. VJ-2721-R4  
Received: 10/21/69

Sub-title: TRUCKS IN RURAL INJURY ACCIDENTS

Final Report

DOT/HS-800 232 or PB-191 172  
Report Date: July 1969

CAL Report No. VJ-2721-R5  
Received: 11/5/69

The remaining four reports that are summarized here are as follows:

Contract FH-11-7098  
Cornell Aeronautical Laboratory, Inc.  
4455 Genesee Street  
Buffalo, New York 14221

NHSB Award Amount: \$200,000.00  
AMA Award Amount: \$200,000.00  
Release Date: 10/23/70

VEHICLE SPEED AND RURAL AUTOMOTIVE CRASH INJURY PART I:

Sub-title: Estimated Traveling Speed and Fatalities

DOT/HS-800 285  
Received: 10/21/70

CAL Report No. VJ-2721-R1  
PB-194 970

VEHICLE SPEED AND RURAL AUTOMOTIVE CRASH INJURY PART II:

Sub-title: Estimated Traveling Speed and Injuries in Single Vehicle Frontal Crashes

DOT/HS-800 286  
Received: 8/18/70

CAL Report No. VJ-2721-R7  
PB-194 971

AUTOMOBILE SIDE IMPACTS AND RELATED INJURIES

DOT/HS-800 287  
Received: 10/23/70

CAL Report No. VJ-2721-R8  
PB-194 972

TRUCKS IN RURAL INJURY PRODUCING AND PROPERTY DAMAGE UTAH ACCIDENTS

DOT/HS-800 288  
Received: 9/9/70

CAL Report No. VJ-2721-R9  
PB-194 973

ESTIMATED TRAVELING SPEED AND FATALITIES

This is a statistical report presenting charts and graphs covering speed estimates in actual ACIR case studies. Observations in the over-all study are based on rural injury-producing accidents investigated by the state police in 31 states that

have participated in the ACIR program over a 15 year period. A description of the data collected is provided in the report. In addition, automobile occupant data of the occupants of injury cars who were at least 15 years of age and did not wear a lap belt or other restraining device are included in the detailed tabulations presented in the report.

The tabulations resulting from all the collected data are summarized, but not in great detail since this phase of the study is in the preliminary stage. This summarization covers the following:

- Average Fatality Rates for Seven Leading Accident Types
- Average Fatality Rates for Four Seated Positions
- Fatality Rates by Seated Position and Accident Type

#### A Need Exists for a Comprehensive Study

Despite a continuing high level of interest in the relationships between speed, accidents and injuries, relatively few meaningful studies of speed are available. Solomon (Ref.1)\* reported accident rates in terms of traveling speed and such factors as time of day, driver age and sex, type of vehicle and horsepower. In an early ACIR report (Ref. 2)\*\* Moore showed the relationship between speed and serious injury or death. An estimate of lives potentially saved through speed control at various levels also was presented. A number of other reports on this subject are listed in a Bibliography at the end of this report.

\* Solomon, D., "Accidents on Main Rural Highways Related to Speed, Driver, and Vehicle." B.P.R. 7/1964

\*\* Moore, John O., "A Study of Speed in Injury - Producing Accidents: A Preliminary Report," American Journal of Public Health, Vol. 48, No. 11, 11/1968

Attempts to interpret speed as an index of injury causation are confounded by the complex relationships between speed, occupant injury, and many other variables. The type of accident, area of impact to the car, car size, and other variables are closely associated with the injury results. It therefore is difficult — and perhaps impossible — to define a simple speed-injury relationship.

In past studies of speed, it has been customary to examine either the reported traveling or impact speed of the involved vehicles. The highest traveling or impact speed estimated in an accident also has been used by ACIR. Thus, in a two-car accident, the speed of the faster moving of the two vehicles would be recorded. However, there are accident circumstances in which any of the

speeds cited may be ambiguous or misleading. For example, in a front-to-rear collision involving two cars, a speed difference of 20 mph when one vehicle is stopped may produce quite a different accident and vehicle damage pattern than when the slower moving vehicle is traveling at 60 mph. The injury consequences also may be quite different. This is largely because the opportunity for a variety of secondary impacts, or for overturn, is greater at higher speeds. Similarly, in a front-to-side impact involving two cars, a striking car that impacts the side compartment area of another vehicle with its front area generally is subjected to lower forces and has a lower injury potential for occupants than a car that meets another head on.

If study results suggest additional research concerning the role of speed in highway accidents, these areas also will be explored by CAL in future studies.

#### Conclusions

Since detailed analysis of the tabulations cannot be attempted at this phase in the study only a few conclusions should be drawn:

- As already shown, fatality rates for ejected occupants are much higher than those for nonejected occupants. This is a time tested conclusion and holds for all speeds and for all accident types. The risk of fatality for the ejected occupants is anything from 2 to 10 or more times as high as given estimated traveling speed, and any given accident type.
- Over most speed ranges, side and front impacts are the most lethal accident types.
- In contrast, rollover accidents, specifically single vehicle rollovers in which the stopping distance is many times longer than that in collision impacts (low V, Section 1), show a low fatality rate at all speeds, especially for nonejected occupants.

#### ESTIMATED TRAVELING SPEED AND INJURIES IN SINGLE VEHICLE FRONTAL CRASHES

This is a synopsis of Part II, "Vehicle Speed and Rural Automotive Crash Injury," CAL Report No. VJ-2721-R7 (DOT/HS-800 286). The reader may now gather from the summary of Part I that the "objective of these studies is to clarify some of the relationships between speed and injury."

In Part II, the speed-injury relationships for single vehicle frontal crashes are examined. However, the objective of this study is to go beyond just quantifying a speed-injury relation. The goal also includes the examination of speed to injury relationships within data subgroups — ejected or non-ejected, seat belted or non-seat belted occupants, children and adults, in various seated positions in both domestic and foreign vehicles.

## Major Findings and Conclusions

Data in the report were obtained from state police and physicians in 31 states participating in the ACIR interstate program. Study data consist of 5,824 cars and 10,859 occupants involved in injury-producing single vehicle frontal impacts. The objective of the study is to clarify some of the relationships between traveling speed and injury in the described impact type.

### • Exposure to Injury

- As traveling speed just prior to accidents increases, the percentage of ejected occupants and seat belted occupants in injury producing accidents increases. This reflects the facts that (1) door opening and ejection are more frequent with increasing impact speed; and (2) seat belts are less effective in preventing any injury in more severe accidents (higher speeds) than in accidents at lower speeds, where in many cases, seat belt use changes potential injury accidents into non-injury accidents.

- Also, as traveling speed just prior to accidents increases, the percentage of adults in foreign car injury producing accidents decreases as does the percentage of children in all injury producing accidents. Foreign cars generally travel at lower speeds than U.S. cars and cars with children also generally travel at lower speeds.

- Overall, 7.9 per cent of all occupants are ejected. At speeds of 60-79 mph, however, 12.7 per cent of all occupants are ejected. About 95 per cent of all ejectees are injured regardless of speed.

### • Injury

Traveling Speed and Injury Frequency among adults and children in terms of belt use, ejection, and speed.

- In general, the occurrence of injury among adults is most frequent for unbelted, non-ejected occupants. Children generally rank below adults, but in the same rank sequence in terms of ejection and seat belt use.

- The same ranking prevails for non-dangerous-fatal, dangerous-fatal and fatal injuries except that the frequency of fatal injury is lowest at all speeds for belted, non-ejected occupants. As traveling speed increases however, the frequency of specified injury degrees also increases. Increases in the frequency of injury become more pronounced as speed and injury severity increase.

- Fatality occurs most frequently at high speeds and, even at these speeds, is more frequent among ejected occupants than among non-ejected occupants. At speeds of 60-79 mph 14.4 per cent of the ejected occupants are killed, compared with 4.5 per cent among non-ejected occupants traveling at these speeds. Even at high speed, fatality is infrequent among belted, non-ejected occupants and, overall, 1.5 per cent of these occupants are killed.

- The frequency of ejection and of non-dangerous to fatal injury is lower for children than for adults. In part, this reflects lower traveling speeds and occupancy of more favorable seats in the car (rear seat, particularly). Also, within given speed ranges, children are injured less frequently than adults.

### • Traveling Speed and Injury Frequency among unbelted occupants of U.S. and foreign cars

- In most speed ranges, occupants of foreign cars received more injury than comparable occupants in U.S. cars. The frequency of dangerous-fatal injury is higher among unbelted, nonejected occupants of foreign cars than among those in U.S. cars and lower for unbelted, ejected occupants. For non-dangerous-fatal injuries, significant differences between foreign and U.S. car occupants are not apparent.

### • Traveling Speed and Injury in terms of belt use and seated position

- The data indicate a fairly pronounced



difference in injury frequency in terms of belt use and seated position. Unbelted, ejected occupants sustain injury with similar frequency regardless of seated position, and differences between seated position are few. Differences in the frequency of injury with seated position are greatest among unbelted, non-ejected occupants.

#### AUTOMOBILE SIDE IMPACTS AND RELATED INJURIES (CAL Report No. VJ-2721-R8, DOT/HS-800 287)

##### Background

The hazard associated with side impacts involving the compartment area has been recognized for many years. Solution of this problem, however, is more difficult than that associated with front or rear impacts because the door and side panel structure in cars offers only limited space for energy absorption. Also, the occupant is quite close to the impact point and the potential for compartment invasion is greater than in most other accident types.

One recent attempt to cope with this problem was the introduction of a steel beam guardrail into the doors of some General Motors cars. Tests indicate that the beam reduces penetration by another car and causes the struck car to skid sideways in front of the striking car. Sufficient case data to evaluate this component were not available at this phase of the study was submitted and cars with this feature are not included.

Data used in the study were obtained from rural areas of 31 states participating in the ACIR program and include only injury-producing accidents. Accident data were provided by State Police officers who completed an ACIR report form and photographed the interior and exterior of the car. Attending physicians completed an ACIR medical report form on all injured victims. Available for study were 1,490 automobiles that sustained side compartment damage as a result of an impact with an object or another vehicle. Sideswipes and overturn accidents are excluded.

Estimates of the area and depth of penetration into the compartment were made, using photographs taken by investigating state police officers. For study purposes, both vehicle damage and occupant injury were examined in terms of body style and chassis frame type.

##### Major Findings and Conclusions

- More than half of the compartment impacts were at a right angle to the compartment, i.e., from a 3 or 9 o'clock direction.
- Overall, the impact speeds of cars that were struck in the side compartment area were lower than those of the vehicles that struck them in two vehicle accidents.
- Approximately 83 percent of the side impacts involved another vehicle; the remainder involved an object, usually a tree or pole.
- Using the ACIR accident severity rating (based on vehicle damage), the largest percentage of cars rated as severe or worse involved side impacts with trees or poles. Side impacts with trucks produced only a slightly lower percentage of these ratings. Collisions with other cars produced the lowest percentage of severe or higher accident severity ratings. Four door sedans and hardtops had a lower percentage of severe or higher ratings than the two door models. The ranking of chassis frame type in terms of the percentage of severe or higher-ratings decreased in the following order:
  - Unitized body
  - X - frame
  - Perimeter frame
  - Parallel frame
- Top damage was associated with side impacts in less than 5 per cent of the cases studied. In impacts with trees or poles, top damage usually resulted from direct impact with the object.
- In collisions with other cars, top damage often was associated with side penetration in the area of supporting structure which tended to pull the top downward. The four door and two door hardtops with top supports only at the corners (corner posts) had less top damage and less severe top damage, than the standard sedans in collisions with other cars.
- There appears to be little relationship between severe chassis frame damage and either moderate or severe compartment damage. This is primarily a reflection of the fact that when two vehicles collided, even if

severe compartment invasion occurred, the striking vehicle usually overrode the frame of the car struck in the side producing relatively little frame damage.

- Severe compartment damage was observed more frequently among two door cars than among four door cars. The frequency of severe compartment damage did not appear to be related to frame type. Moderate or severe chassis frame damage was least frequent among cars with perimeter frames and most frequent among those with parallel frames, while unitized and X-frame cars had about the same frequency of damage.
- Severe compartment invasion occurred in 92.2 per cent of the side impacts. Damage most frequently involved in the compartment level above the frame and below the lower line of the side windows (91 per cent).
- A narrow pattern of compartment penetration extending from the frame to the top of the car was typical of tree or pole impacts. Collisions with other vehicles produced a broader penetration pattern, but invasion also extended from frame to top most frequently.
- Maximum compartment penetration of 12 inches or more occurred in about 11 per cent of the cases studied. Another 25 per cent of the cars had invasion of 6 to 12 inches. Penetration of the compartment area to a depth of more than 12 inches occurred most frequently in impacts with trees and poles or with trucks.
- The frequency of dangerous or fatal injury is almost twice as great, overall, for occupants seated on the side of the car impacted, as for those away from the impact. It appears that occupants in hardtops sustain dangerous-fatal injury less frequently than those in sedans.

#### TRUCKS IN RURAL INJURY PRODUCING AND PROPERTY DAMAGED UTAH ACCIDENTS (CAL Report No. VJ-2721-R9, DOT/HS-900 288)

##### Background

In March of 1965 the Automotive Crash Injury Research project (ACIR) initiated a program of vehicle-accident data collection in the state of

Utah. During the time period from September 1, 1965 to August 31, 1967, ACIR received information pertaining to the rural injury producing and property damage accidents investigated by the Utah Highway Patrol. A total of 7,650 rural accidents were reported to ACIR over the two year period. Approximately 28 percent (2,130) of the accidents reported involved a bus, truck, or multipurpose-passenger vehicle.

ACIR reviewed those accident reports and recoded the information obtained from those accidents in which a multipurpose passenger vehicle (MPV), truck, or bus was involved. With the aid of the Ad Hoc Research Planning Subcommittee of the Motor-Truck Safety Research Committee of the Automobile Manufacturers Association, Inc., 18 general MPV, truck, and bus types have been defined. Each vehicle in the study group has been classified according to power unit, cab type, and vehicle group. In Appendix 2 of the report, the reader will find the definitions of the vehicle groups, cab types and types of control units. The distributions of the vehicle-study group by make, year of manufacture, control type and cab type appear in Appendix 3 along with marginal distributions of the study vehicles by various accident factors and occupant characteristics which have been obtained for each of the 18 vehicle types.

Summary figures — derived from a subset of observed distributions appear in a separate section in the report entitled, "General Observations" in order to provide a description of MPV, truck and bus accidents and to make comparisons between the vehicle types.

Information pertaining to those accidents in which a jackknifing, a severed connection, or a truck-auto underride occurred is also presented.

ACIR has conducted two other truck studies based on data evolved from rural injury accidents. In addition to the fact that the data presented were collected from property damage and injury-producing rural accidents, the basic information in the study was obtained from a modified police report form, whereas the data in the other studies were obtained via a specifically designed truck report form.

##### Major Findings and Conclusions

Information pertaining to 2,366 multipurpose passenger vehicles (MPV), trucks and buses involved in 2,130 rural injury producing and property damage accidents was studied. During

the study period (September 1965 to September 1967), the Utah Highway Patrol reported a total of 7,650 accidents to ACIR. In addition to distinguishing between school buses (21) and other buses (30), the five major groups—MPV (158), pickup (1,289), van delivery (69), straight truck (442), and tractor-trailer combination (357)—were refined so that in total, eighteen vehicle types were examined. This resulted in the findings and conclusions that follow:

- Tractor-trailers were involved in accidents during the period from midnight to 6 a.m. more often than other vehicle types.
- The multipurpose passenger vehicles and pickup trucks, which are frequently used for social as well as commercial purposes, were more often involved in a weekend accident than the other vehicle types. Among the remaining commercial types, the tractor-trailer units were most often involved in a weekend accident.
- The MPVs and tractor-trailer combinations had the highest frequency of one-vehicle accidents.
- The dump units, stake straight trucks, buses, and camper pickups had a relatively high percentage of vehicles subjected to a rear impact.
- The carryalls, utility vehicles, towing pickups, and tractor-tank combinations had the highest frequencies of rollover accidents. It was noted that the utility vehicles had a high frequency of rollover and yet were rarely traveling at speeds exceeding 60 miles per hour.
- Approximately one-third of the vehicles were damaged to a minor extent and eleven percent to an extent classified as greater than moderate. The utility vehicles (18.4 per cent), regular van delivery (17.6 per cent), and carryalls (15.0 per cent) most often were damaged to an extent classified as exceeding moderate. Two-thirds of the dump trucks and one-half of the towing pickups were damaged to a minor degree.
- Roughly four per cent of the drivers were ejected. Relative to the ejection rates for the drivers of the other vehicle types and with an exception for those drivers of the utility vehicles, the rate of ejection was noted to be slightly higher for those driving a tractor-tank unit or a vehicle in the miscellaneous straight truck group. Of the 70 drivers of utility vehicles, 14 (20 per cent) were completely ejected from the vehicle. The per cent of truck occupants known to be ejected through windshield was less than one-half of one per cent (0.3); or approximately 10 per cent of all ejections with area of ejection specified.
- Injury to an occupant in 23.8 per cent of all the case vehicles. This frequency was highest among the occupants of the utility group (44.9 per cent), followed closely by those of the van delivery (40.4 per cent), carryall (35.2 per cent), and camper pickups (31.7 per cent). As the size of the case vehicle increases, the frequency of injury to an occupant tends to decrease. However, this frequency of injury was higher for occupants of the tractor-trailer units than for those of the straight trucks.
- When a case vehicle (truck, MPV, or bus) is involved in a multivehicle accident, the vehicle responsible for the greatest damage to the case vehicle is designated as the principal other vehicle. The overall frequency of occurrence of injury in a principal other vehicle was 23.6 per cent and was highest (40.7 per cent) for the situations where the principal other vehicle collided with a semi-unit. In general, the frequency of injury to an occupant of a principal other vehicle increased as the size of the vehicle struck increased.
- The frequencies of occurrence of injury and of more serious injury or death, were essentially the same for drivers of pickups and tractor-trailers.
- Of the 357 tractor-trailer combinations in the study, 45 (12.6 per cent) were noted to have jackknifed prior to (primary jackknifing) or during (secondary jackknifing) the accident sequence. The road surface was reported to be wet or "snowy slippery" in the majority of the cases involving a primary jackknife. The vehicles were traveling down a grade in approximately one-half and around a curve in approximately one-third of the primary cases.

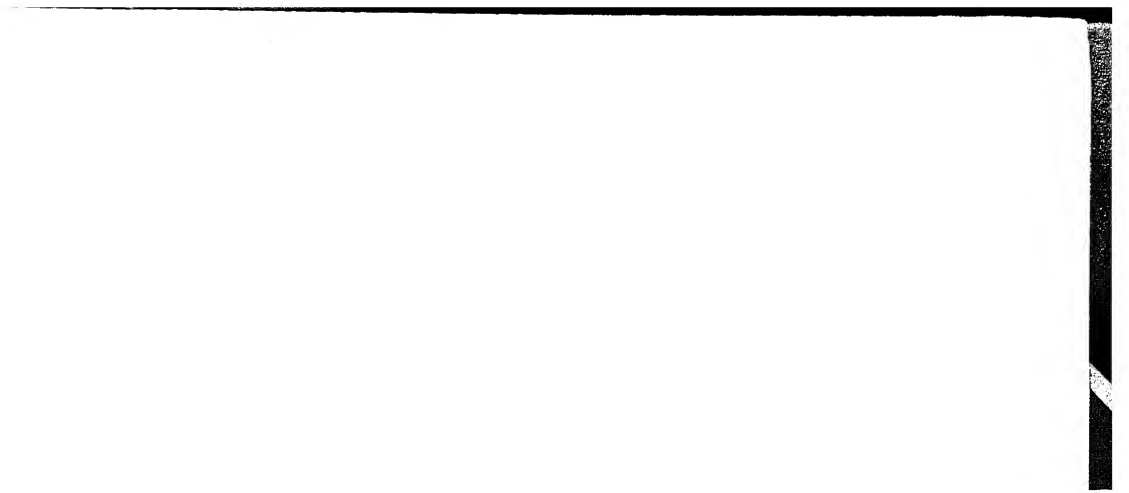
- ° A total of 37 "underride" instances involving a semi-unit (16) or a straight truck (21) were noted in the auto-truck collisions reported to ACIR. Information pertaining to the impact configuration, year and make of the auto, impact speed, underride configuration, and injury is presented for each of the cases.
- A unit of combination was observed to have separated from the tractor or semi-trailer in 28 cases. Such separation occurred either during a time when one of the units of the combination was in the process of rolling over (19) or as a result of an impact (5) or a vehicle failure (4).

The Contract Manager has certified that the contractor's work has been satisfactorily completed and that all contractual obligations have been met.

The opinions, findings, and conclusions expressed in this summary are those of the contractor and not necessarily those of NHTSA.

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